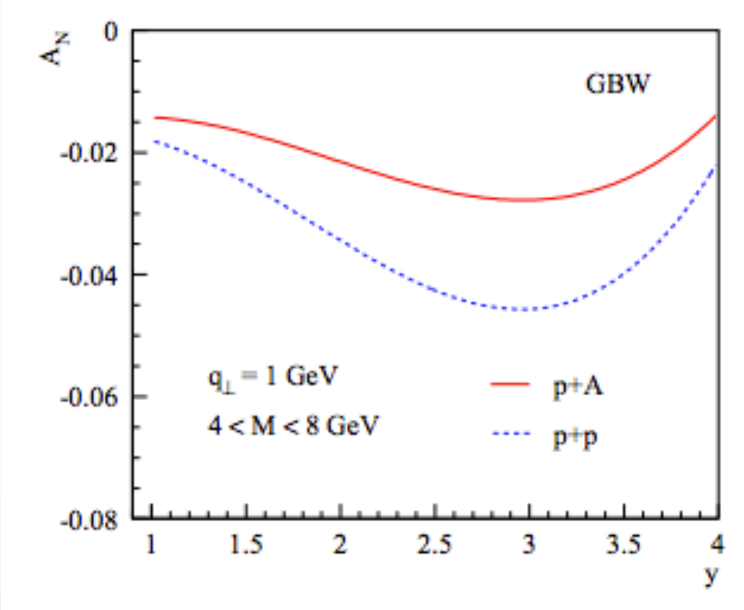
Comments: polarized pA

Zhongbo Kang

Discussions with Yuri

A_N suppressed or enhanced?

- A_N suppressed?
  - The known ones from Collins formalism + CGC framework: polarized pA is suppressed compared with pp
  - Similar thing happens for Sivers effect: DY A_N 1212.4809 (Kang, Xiao)



$$\frac{A_N^{pA}}{A_N^{pp}} \sim \frac{Q_{s,p}^2}{Q_{s,A}^2} \quad \text{for low } p_T$$

$$\frac{A_N^{pA}}{A_N^{pp}} \to 1(0) \quad \text{for high } p_T \ \text{(Kang-Yuan/Kovchegove-Sievert)}$$

Nuclear PDFs → Nuclear TMDs

- RHIC has made great contributions in constraining nuclear collinear PDFs: EPS09, DSSZ, ...

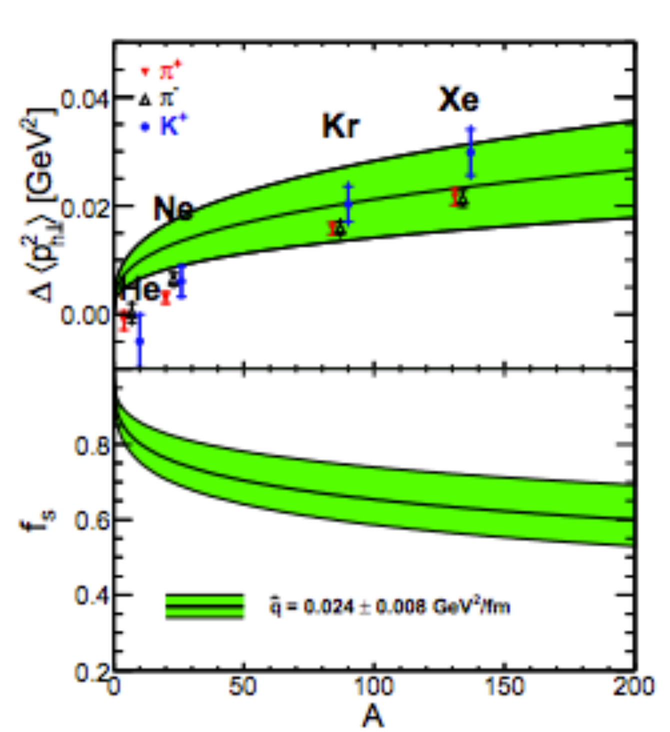
- Could this be generalized to nuclear TMDs??
  - There are discussions/papers written by e.g., Xin-Nian Wang and his collaborators 0801.0434, 1402.3042

$$f_p(x, k_\perp) \sim \frac{1}{\pi \langle k_\perp^2 \rangle} e^{-k_\perp^2/\langle k_\perp^2 \rangle}$$

$$f_A(x, k_\perp) \sim \frac{1}{\pi \langle k_\perp^2 \rangle_A} e^{-k_\perp^2/\langle k_\perp^2 \rangle_A}$$

$$\langle k_\perp^2 \rangle_A = \langle k_\perp^2 \rangle_p + \Delta \langle k_\perp^2 \rangle$$

Broadening from multiple scattering



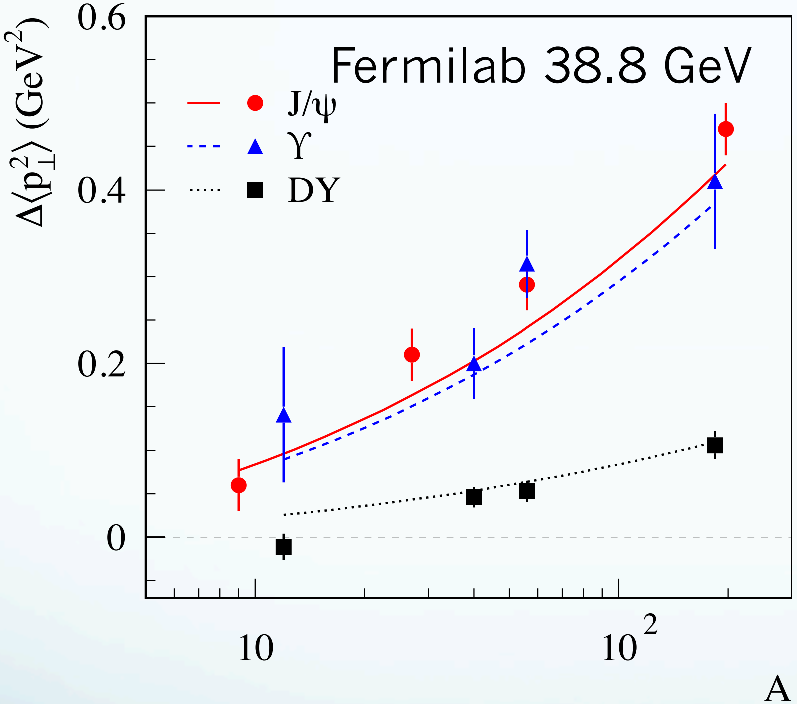
- Yuri also had studies on nuclear TMDs using saturation formalism: 1505.01176 (Boer-Mulders, ...)

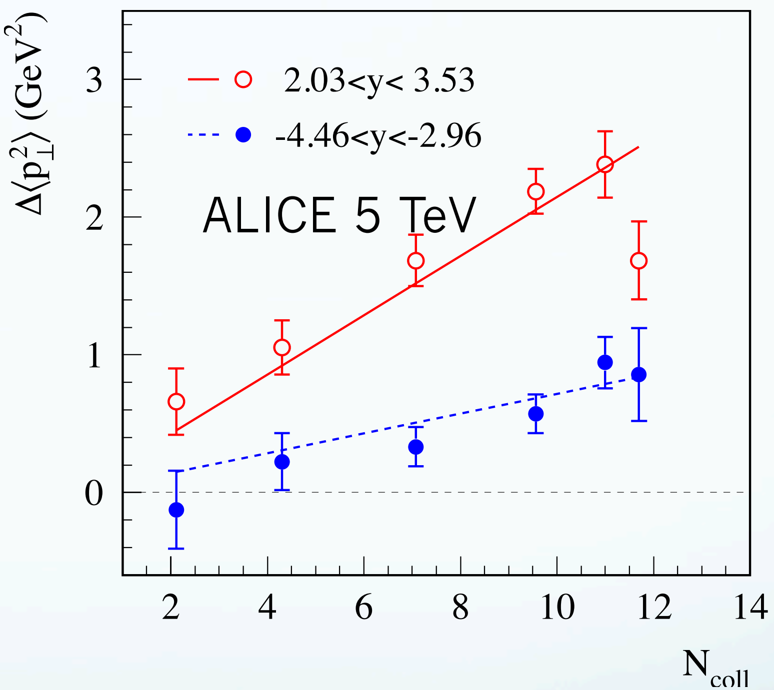
Spin-dependent transverse momentum broadening

- Transverse momentum broadening: azimuthal integrated

$$\Delta\langle p_\perp^2\rangle = \langle p_\perp^2\rangle_{pA} - \langle p_\perp^2\rangle_{pp}$$

Kang-Qiu, 1212.4561





Azimuthal dependence of broadening

- This could then introduce spin-dependence since all the spin effects only exist when we have azimuthal dependence (EIC white paper)

$$\langle p_T^2(\phi)\rangle_A = \int dp_T^2\, p_T^2 \frac{d\sigma_{eA}}{dx_B dQ^2 dp_T^2 d\phi} \Big/ \frac{d\sigma_{eA}}{dx_B dQ^2}$$

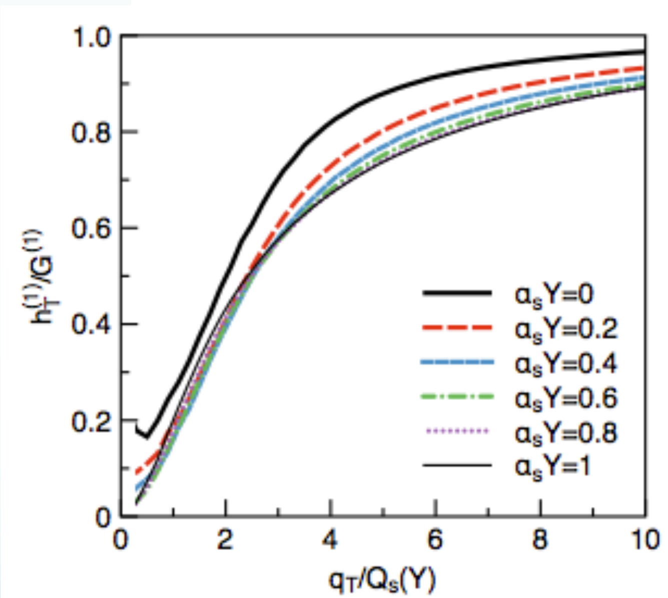
  - Yuri-Matt: cos(2φ)
  - Qiu-Pitonyak: related to Boer-Mulders somehow?

Gluon TMDs

- Probably the so-called gluon Boer-Mulders function is most discussed in recent years

1508.04438, Dumitru, Lappi, Skokov

$$E_1E_2\frac{d\sigma^{\gamma_T^* A\to q\bar{q}X}}{d^3k_1d^3k_2d^2b} = \alpha_{em}e_q^2\alpha_s\delta\left(x_{\gamma^*}-1\right)z(1-z)\left(z^2+(1-z)^2\right)\frac{\epsilon_f^4+P_\perp^4}{(P_\perp^2+\epsilon_f^2)^4}$$
$$\times\left[xG^{(1)}(x,q_\perp)-\frac{2\epsilon_f^2P_\perp^2}{\epsilon_f^4+P_\perp^4}\cos\left(2\phi\right)xh_\perp^{(1)}(x,q_\perp)\right]$$



Similar for charm pair production in pA

Can also be done by photon+jet, ..., e.g., Boer, Vogelsange, Qiu, ...

$$\frac{d\sigma}{d\mathcal{P}.\mathcal{S}.}=\frac{\alpha_s^2N_c}{\hat{s}^2(N_c^2-1)}\left[\mathcal{A}(q_\perp^2)+\frac{m^2}{P_\perp^2}\mathcal{B}(q_\perp^2)\cos 2\phi+\mathcal{C}(q_\perp^2)\cos 4\phi\right]$$

Akcakaya, Schafer, ZJ 2012